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ABSTRACT

Because the ability to write reports and make oral presentations is crucial to success, the Department of Chemical Engineering at the University of California (Berkeley) has set up an in-house, required course that is given every semester to about 60 students. Divided into three sections, one of which is for non-native speakers of English, the course is graded on a pass/not pass basis, and the only route to exemption is a tough exam that only about 2 percent of the students pass. Activities are organized around three concepts. First, a professional context is developed. Next, change is fostered by interlocking assignments. Third, students take responsibility for their own verbal development. The teacher is the manager of course material for each student and for the group, modifying the context to facilitate each student's development. As in all communication situations, there must be an observing, responding, and shaping of intelligence. (DF)

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A Matter of Chemical Engineering

(On Teaching An Intensive Course in Technical Communication for Undergraduates)

by

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Introduction

If any place is more performance oriented than academia, it is the professional world, the world that senior students in chemical engineering are soon to enter. There the ability to communicate effectively is crucial to success. To put it bluntly, the difference between a chemical engineer who can write and one who can't is roughly $20,000 a year.

However, those with a bent for engineering are often weak in verbal skills. By the time they have reached senior year and are about to write reports and make oral presentations for the unit operations laboratory, most students need help - and quickly. They must cope with verbal tasks they have been avoiding through years of schooling. Our task is to help them.

For that purpose, the UC Berkeley Department of Chemical Engineering set up an in-house, required course that is given every semester to about sixty students. It is divided into three sections (one of these is for non-native speakers of English) and graded on a

pass/not pass basis. The only route to exemption is a tough exam that only about 2 percent pass. In addition there is a consulting service, mainly for students writing reports for the unit operations laboratory, but also available to others. Now in its sixth year, the program is staffed by three experienced teachers of composition.

In Chemical Engineering 185, Technical Communication for Chemical Engineers, we teach the use of clear prose and effective oral delivery in the essential communication tasks of professional life. We have found that even students who are relatively competent writers need guidance in making the change from writing essays for college courses to writing reports for supervisors and clients. After all, nothing short of a change in behavior is called for. We are asking college students to act like professionals.

There are three concepts around which our activities are organized. First, we develop a professional context - the web of attitudes, expectations, and practices found in the professional world of the chemical engineer. Next, change is fostered by interlocking assignments. Each assignment is layered to teach multiple tasks and these assignments are arranged in sequences that reinforce earlier learning while also giving an encouraging sense of progress.

Third, students take responsibility for their own verbal development. Every assignment involves self-evaluation as well as teacher reaction. Our students must come to understand that once out on the job, they must know how to monitor their own performance as well as that of others. To that end, we design self-evaluative techniques into assignments as deliberately as we teach the keys to summarizing or the organization of a report.

I. What do we mean by context? Though we teach the basic processes of effective discourse, our special task is to prepare professionals. Thus, there is an urgency and a sense of purpose that we can make work for us in motivating students. Of course, the Chemical Engineering Department has given us an enormous boost in requiring this as a prerequisite to the laboratory course where students find out what it is like to function as engineers. Professors in the department give us valuable feedback. We build from that base.

At the outset, we present the course work in writing and speaking as a crucial part of professional training. Guest speakers, who are successful professionals, reinforce this message. We follow through by couching assignments - usually in case form - and in the context of the professional world with its manners and standards.

Early on, our students learn the difference between discourse as self-expression and discourse for professional purposes. We take the movement from writer-based to reader-based prose a psychological step further. Our students must not only write or speak with an audience in mind, but must learn to regard themselves as experts or decision makers writing for a supervisor or a client rather than as bright youngsters writing for a professor who knows more than they do. They must come to see that although all writing and speech is self-revealing, when they communicate in professional situations, they are delivering a product that others will use for their own purposes just as others will use the chemical processes they develop.

In industry, one learns from mistakes and corrects them. We cultivate that attitude in regard to the process of rewriting. Therefore, a student can expect to revise a paper - not because he has failed - but because that's a necessary part of doing a good job.

The industrial world as metaphor is built into the structure of each assignment. We present assignments in the form of cases based on situations our students are likely to encounter as young professionals. In each case, the writer's role is defined and the audience specified. For instance, an assignment may ask them as process engineers in a company that manufactures refrigeration equipment, to write a memo for the sales staff explaining how a home refrigerator works. They must explain what happens, why, and with what effects at each stage of the process in terms understandable to intelligent laymen, college-educated graduates in business administration. And always, since the business world runs within limits and constraints, there is a word limit and a deadline.

They also learn that audience analysis is part of the process, requiring adjustments in diction and tone for different audiences. In this way, they begin to think of themselves in roles different from that of student.

II. In interlocking assignments, we must begin at the level where we find the student and where he finds himself. Most students come to us innocent of the knowledge of what is involved in sound writing process. The mutual goal is to demystify the process so that students come to see that producing clear prose is hard, but manageable, work. We first walk them through the process, breaking it down into manageable steps (planning, 1st draft, editing, 2nd draft, editing, 3rd draft) and structuring these steps into the first assignments. The first paper is a technical description. For that, they must first bring to class an outline and a rough draft; these are edited and commented on by a

classmate with the teacher consulting in a workshop session. Students then incorporate the comments and reactions of others into another draft. They learn that they have to excercise judgment about what to accept and what to reject. The teacher receives all drafts and outlines along with a self-evaluative statement about what the student felt were major problems encountered in producing the paper. After the teacher reacts and, if necessary, calls a conference, the student must rewrite the paper. He thus experiences what is involved in writing. On subsequent papers, the teacher encourages shows of progress, but insists upon page-editing or revision of certain passages or complete rewrites when necessary.

Once the student is at home with the writing process, what proficiency goals do we help him establish? We teach first of all that the sine qua non of professional discourse is clarity. It must also be focused and complete, yet concise. Since these basic requirements must be met in writing reports and technical descriptions, students must also learn to condense and paraphrase information as well as to argue persuasively; they also have to explain, to give clear instructions, and to present complex material through tables and graphs. They also must learn to assess audience and alter each presentation accordingly, to write under pressure, to meet deadlines, and to edit their own writing as well as that of others. In addition, since communication is oral as well as written, they must learn something about negotiation, advocacy, interviewing, and group discussion as well as delivering a talk. Therefore, speech is integrated into almost every assignment. From the

first day students are encouraged to speak on all classroom occasions as if they were present at a business meeting. They start the semester by introducing themselves (or sometimes each other) just as they might be asked to do in a business situation.

Because feedback is essential to improvement, it is also structured into these assignments. In addition to self-evaluation and peer evaluation in speech activities, we use that wonderful technological development, the video camera. Our students are videotaped about 4 times during the semester; we have playback sessions in class and students go back for private viewings of their taped talks. The difference between first and last performances is dramatic.

To provide maximum exposure to various aspects of communication, each assignment is layered with multiple tasks - reading (research), speaking, listening, writing, editing. For example, a lesson in technical description requires each student to research and describe a process or mechanism orally to a teammate who is obliged to write the description on the basis of what she can learn from her partner. Then they reverse roles with the teammate presenting a different technical process. Each, in the role of speaker must plan and do research as well as speak clearly; each as writer must listen carefully and ask questions in order to produce a lucidly written explanation of causal principles.

At the next class session, each speaker is given the task of editing the paper the teammate wrote on the basis of the oral presentation. In this way, each student sees her work mirrored back by a peer and evaluates the work of at least one other student. Thus, in

practicing editing and evaluation before the teacher sees the papers, students act again as if they were professionals, for often in industry oral presentation is followed by discussion and questioning, eventually to result in a memo or report.

III. In addition to layering each assignment so that multiple tasks are performed, we arrange them in sequences to reinforce learning; in these sequences key tasks are repeated in varying forms. For instance, in condensing and paraphrasing information, most students need several tries before they perform well. The first exercise in condensing and paraphrasing is done in class. We read a short speech delivered by an industrial leader on what constitutes an educated person. Then each of us, teacher as well as students, condenses the opening paragraphs into one sentence. After listening to several attempts read aloud, we discuss the difference between key points and incidental information.

Next, the student, understanding that his task is to distinguish major from minor points, is asked to outline an article written by two professors of chemical engineering who advocate the necessity for engineers to improve their writing. In this assignment, the student is given further instruction in outlining as well as in summarizing. He brings his outline of the article to class where, warned in advance, he must test its value by writing within a time limit (say 20 minutes) a summary of the main ideas. This early try at writing an abstract or a summary also gives the students the experience of writing under

pressure, something they will have to do on the job. Such pressure also smokes out weaknesses, alerting both student and teacher to spelling, grammatical, and organizational problems that can be covered up when the student takes more time - or gets help - outside of class.

The next assignment in writing the abstract is combined with the first lesson in argumentation. At some point in his career every chemical engineer must become an advocate. For example, we assign a brief persuasive article by an executive in a major chemical corporation. Students are asked to again outline main points and to express the gist of the argument in condensed and paraphrased form. In addition, the article is evaluated as advocacy. Students must read critically in order to analyze the argument as well as to summarize it. Because it is well written, we also use it to demonstrate paragraph coherence and emphasis. Following this, we move on to more work on advocacy, but abstracting is not dropped. It becomes a part of other assignments, particularly in writing reports, for every report must have an abstract or summary.

Pace is another factor in sequencing assignments. Changing pace gives students a sense of progress. Care must be taken so as not to pile on more work than the students can manage, yet enough to keep them stimulated.

From the beginning we set high standards for writing, revising, and rewriting. However, to show that competent writing is within the grasp - albeit with effort - of most students, we choose as models of effective writing and speaking the work of professors, professional engineers, executives. Students are expected to evaluate the spoken and written communication of peers, guest speakers, and the writing staff. That means they scrutinize attainable models.

IV. The final concept - self-evaluation - gives students a sense of progress. Gradually we increase the demand on their powers of self-perception, being sure to get them to recognize successes, as well as difficulties.

We stress self-evaluation because we want each student to experience taking control of his own improvement. Self-evaluation also gives the student practice in yet another part of adult work-life - holding oneself accountable. So, with each assignment, the student must crystallize for himself what he has learned and what he must do to improve.

Students are asked to evaluate their work both in conference with the teacher and in written forms that they hand in with certain assignments at the beginning, middle, and end of the semester. Self-evaluation forms are short, containing versions of two basic questions: 1) what was mastered? 2) what needs more work? For instance, a shy student might celebrate that he actually stood up in front of a group and spoke for two minutes straight without falling to pieces; another student might recognize that she now recognizes the relationship between punctuation and meaning; yet another, that he now understands how to go about organizing a report. In such ways, the student experiences positive gains he may have otherwise overlooked and the teacher finds out who tends to be overly self-critical, who to be quick at self-congratulation.

Because we are working to change attitudes and thus behavior, we must consider motivation. Yet students differ markedly in their patterns of motivation. They differ in capacity for self-assertion as well as in responsiveness to instruction and criticism. The teacher seeks to

establish a context where the student knows that the burden of taking initiatives and making progress is on him, while at the same time he can turn to teacher and classmates for help and support in their roles as consultants. The constant reminder of the business world they are soon to enter also helps motivate students.

The teacher, besides being a cheerleader and consultant to budding executives, models attitudes towards communication: business-like, yet human; holding high standards, yet spurring students to do what they can at whatever level they can. In regard to his own writing and speaking, the teacher should be frank about his difficulties with the process. For instance, he invites students to find ways to make the assignment sheets clearer. He also works collaboratively with students on some assignments, demonstrating how to take as well as to give criticism. Above all, the teacher demystifies communication. Lucidity becomes not a magical property given to some and withheld from others, but the end result of a process, subject to human frailty yet accessible to effort.

The teacher is, in sum, the manager of course material for each student and for the group, modifying the context to facilitate each student's development. The elements combine in complex ways; it is in part a matter of classroom chemistry. But as in all communication situations, there must be an observing, responding, and shaping intelligence watching the reactions. Perhaps the term chemical engineering, can, after all, be used as a metaphor for teaching an undergraduate course in communication for professional purposes.